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RESEARCH ARTICLE

A revision of *Agonopterix lacteella* (Lepidoptera: Depressariidae) and establishing *A. pallidior* as a junior synonym

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Abstract

Agonopterix lacteella (Caradja, 1920) was described on the basis of a single female specimen collected at Kasakewitsch, Russian Far East. Later on, *A. pallidior* (Stringer, 1930) was described, based on 6 specimens from Japan. Both descriptions where based only on the external appearance and published without illustrations, making subsequent accurate identification of both these species difficult. A subsequent comparison of *A. lacteella* holotype with the type series of *A. pallidior* revealed a perfect match. However, since the holotype of *A. pallidior* is a male whilst *A. lacteella*'s holotype is a female, a revision based on a direct comparison of the genitalia features of these two types is not possible. Hence, the female genitalia of *A. lacteella* holotype was compared with the genitalia of a female specimen identified as *A. pallidior*. A perfect match was found, which leaves no doubt that both taxa are conspecific. Details and consequences of this result for the systematic position of these two taxa, as well as for their relationship with other similar, cognate species are presented. In addition, new data regarding the distribution and biology of *A. lacteella* are presented.

Keywords

Depressariidae, established synonymy, Far East fauna, DNA barcodes

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PENSOFT

Introduction

During the first decades of the 20th century, Aristide Caradja (1861–1955), at that time already a prominent Romanian entomologist, received a large number of micromoths collected from different regions of the Far East. The processing of this material gave him the opportunity to describe a large number of previously unknown species. One in particular drew his attention through its unique wing pattern and ground colours of its forewings, so he decided to name it *lacteella*. However, Caradja made only a brief description of this new species, comparing it with *Agonopterix ocellana* (Fabricius, 1775). Even if correct and accurate, Caradja's description was rather concise and not detailed enough to support a correct identification avoiding confusion with other similar species. Also, there were no figures to complete this description and offer an image of the specimen designated as type by Caradja.

A decade later, apparently without being aware of Caradja's works, Herbert Stringer described several new species based on material from the collections of NHM London. Among them, 3 species were assigned to *Depressaria* Haworth, 1811 (actually in the genus *Agonopterix* Hübner, 1825). One, with type series collected in Japan, was named *A. pallidior*. The specimens that supported the description of this new species were collected in August 1886 in Hakodate, Hokkaido (the holotype), May 7, 1902 in Junsai Numa, Hokkaido (1 paratype) and May 28, 1896 in Shoki, Shikoku (4 paratypes). It is worth noting that Stringer selected one of them as holotype and the other members of the series have become paratypes. All of the members of the type series were established based only on the evaluation of external features and none of the type specimens of *A. pallidior* was dissected. Despite being more thorough in his description than Caradja, Stringer made no attempt to highlight the distinctive features that make this specimen different from any other *Agonopterix* species. Also, no species similar to the new one described was mentioned.

During late 2017, the senior author visited MGAB to study the collection of Depressariidae, especially Caradja´s types. On this occasion, the junior author draw attention to *A. lacteella*, which was known only from the holotype and has never been found since, a fact which appeared very unlikely. A comparison with other Far East species of *Agonopterix sp*. soon revealed the existence of a similar species, well documented and abundantly collected i.e. *A. pallidior*. The genitalia of the female holotype of *A. lacteella* showed a perfect match with a female of *A. pallidior* from ZMB Berlin, indicating that *A. pallidior* might be a junior synonym of *A. lacteella*.

Since the holotype of *A. lacteella* is a female and the holotype of *A. pallidior* is a male it is not possible to compare their genitalia. However, on the assumption that fresh specimens of *A. pallidior* cannot be mistaken for any other congeneric species based on external features, then a comparison of the genitalia of the holotype of *A. lacteella* with the genitalia of any female of *A. pallidior*, which matches externally the holotype of this species should be enough to identify any differences between these two taxa.

Legs from 3 specimens of *A. pallidior* were used to run DNA sequence analysis, resulting in 2 full length barcodes and one with 569 bp. The *A. lacteella* holotype was barcoded according to NGS-protocol (Prosser et al. 2015) and 389 bp had been successfully sequenced, a result fairly good for a specimen collected in year 1907. This section proved to be 100% consistent with the corresponding part of the sequence of specimen DEEUR 6515 (fig. 11) and confirms the conspecifity of these two taxa.

Specimens from the following collections were examined:

MGAB – "Grigore Antipa" National Museum of Natural History, Bucharest, Romania

NHMUK – Natural History Museum, London, U.K.

ZIN – Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia

ZMB – Museum für Naturkunde, Berlin, Germany

ZMH – Zoological Museum, Helsinki, Finland

ZMUC – Zoological Museum of the University of Copenhagen, Denmark

Results

Order Lepidoptera
Superfamily Gelechioidea
Family Depressariidae sensu Heikkilä et al. (2014)
Subfamily Depressariinae
Tribe Depressariini
Genus *Agonopterix* Hübner, 1825

Agonopterix lacteella (Caradja, 1920)

(Figs 1–8)

Type material: Holotype (Fig. 1): ♀, "Kasakewitch" [= Kazakevichevo, Khabarovsk Territory, Russian Far East] rsp. "Kasakewitsch" in original description | Ussuri R. | E. Siberia | Korb 1907; 5750 | WLSM. 1908; Holotype | *Depressaria lacteella* | ♀ Car. (MGAB).

Additional material examined:

Agonopterix pallidior holotype, ♂, Hakodate [Japan], August 1886, Leech | Walsingham collection 1910–427 | NHMUK 010891106 (Fig. 2)

A. pallidior, Norikura Kougen | Azumi, Nagano [Japan] | Grow wing 20.VII. 1984 | Larva coll. 30.VI.1984 | Host plant written in Hiragana: inu-enju = *Maackia amurensis* | K. Fujisawa leg; Brit. Mus. 1989–187; NHMUK 010891107

A. pallidior: Japan | Hokkaido | Isikari | [leg.] Zyozankei | 27.VI.1978 | (Larva col.) | Host: *Maackia amurensis* | 16.VII.1978 | (Emergence) | T. Saito; *Agonopterix pallidior* | (Stringer) | det. T. Saito (dissected female, coll. ZMB, DEEUR 5921). The DEEUR ("Depressariinae of Europe") number was used by the senior author and

Figure 1. *Agonopterix lacteella*, holotype and its labels.

serves as a unique identification code for all studied specimens of Depressariidae. Here, this unique number is used to avoid the repetition of all data if a specimen is mentioned more than once in this paper.

A. pallidior: Russia, Ussuriskaja Kraj, leg. larva from *Maackia amurensis* 17.VI. 1966, pupated 6.VII., emerged 25.VII.1966, leg. Kuznetzov (coll. ZIN, DEEUR 6646)

A. pallidior: Russia, Evreiskaja AO [Jewish Autonomous Oblast], Sapoved. Bastak, Paseka Polkovnikova, 3.X.2009, leg. V. V. Dubatolov (coll. ZIN, DEEUR 6645)

A. pallidior: NE China, Heilongjiang District, Fenglin Bios. Reserve, 14.V. 2000, leg. J. Kullberg (dissected male, coll. ZMH, DEEUR 6515)

A. pallidior: [Japan] Hokkaido | Misumai | 27.VI.1978 | (Larva col.) | 17.VII. 1978 | (Emergence) | T. Saito | Host: *Maackia amurensis* (coll. ZMUC, DEEUR 3780)

Figure 2. *Agonopterix pallidior*, holotype. Scale intervals in mm.

Diagnosis: Wingspan 27 mm. Antennae pale ochreous, darker outwardly. Palpi pale ochreous, second segment thickly clothed beneath, with some fuscous scales externally, third segment with basal and median bands of fawn-brown. Thorax pale ochreous, shaded and spotted fawn-brown. Abdomen greyish brown, anal tuft paler; ventral side with distinct fawn-brown spots. Legs pale ochreous, spurs and tarsi fawn-brown irrorated. Fore wings slightly enlarged towards termen, apex acute, but not really sharply, outer margin behind apex concave (Fig. 3/1 – not previously mentioned by Stringer [1930]), tornus rounded; 2 and 3 stalked; irregularly and repeatedly sprinkled fawn-brown, particularly along the costal half, a triangular fuscous spot at the base of costa (Fig. 3/2), first discal stigma blackish, an additional oblique dot in front and above it, second discal dot indicated by a blackish suffusion, a ferruginous dash followed by a dot of the same colour immediately below this suffusion (Fig. 3/3 in the insert, a diagnostic important feature not mentioned by Stringer [1930]); a diffuse, elongated elliptic area contrasting against ground colour by being a little paler extends from centre of forewing to outer margin, not quite reaching it (Fig. 4, highlighted in red – a feature not mentioned by Stringer [1930]), in some specimens extending further to rear margin and wing base, but less distinct; a terminal series of fawn-brown spots; cilia pale ochreous, darker towards tornus; underside, costa irregularly spotted throughout with dark brown scales, a reduplicated dark brown spot at apex. Hind wings shiny ochreous grey; cilia paler, a basal fuscous line; underside, apical area with scattered brown scales

Female genitalia (Figs 6, 7): Identification should be based on the combination of several features, since each separate feature can be found in some other con-

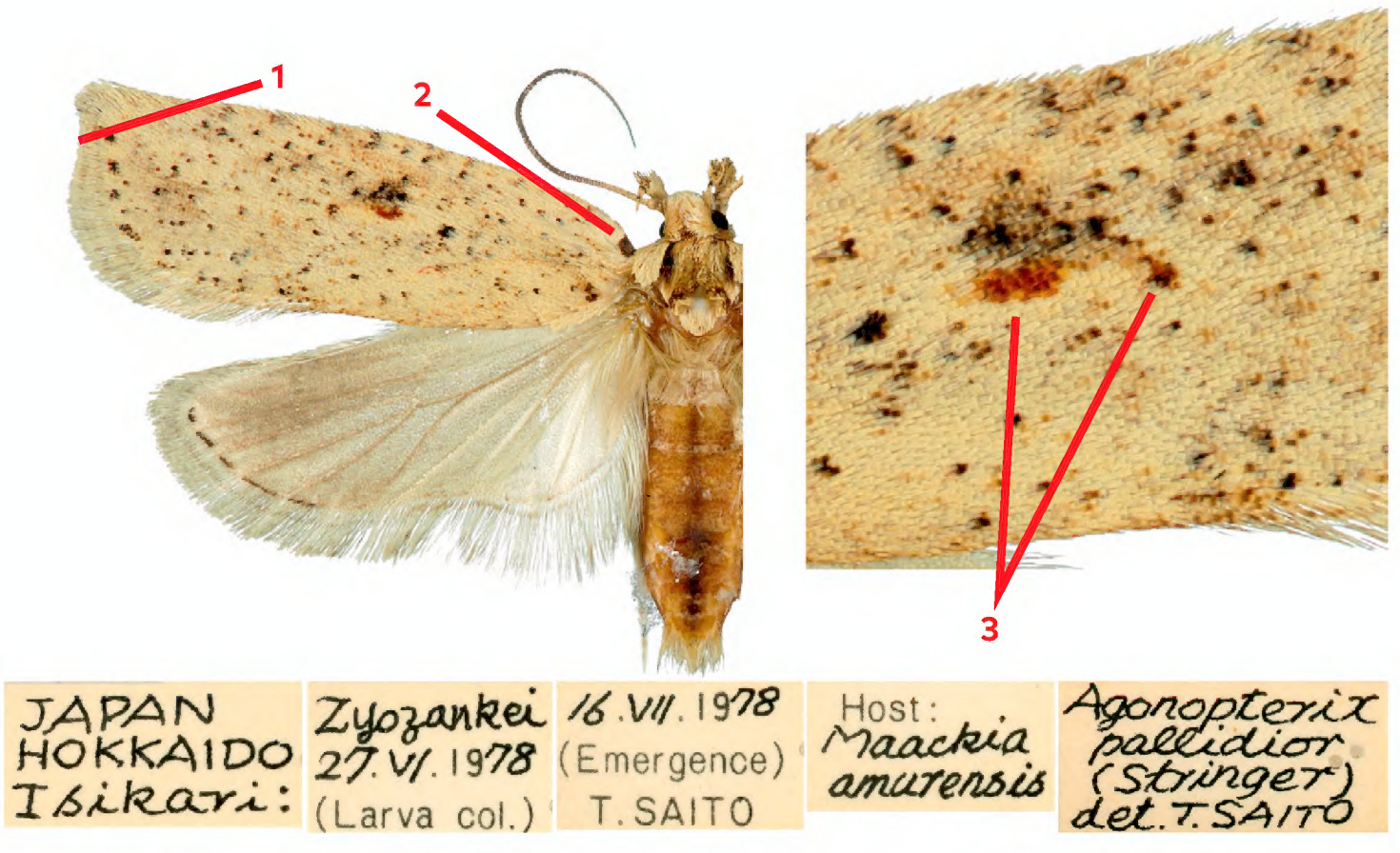


Figure 3. *Agonopterix "pallidior"*, DEEUR 5921; middle section of right forewing enlarged.

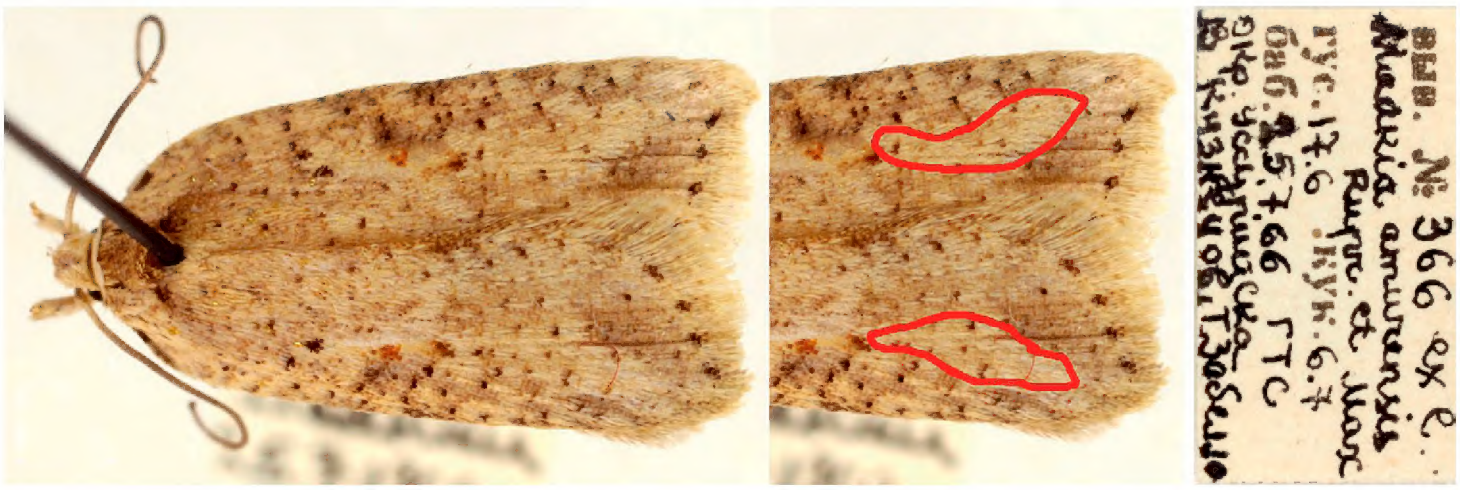


Figure 4. *Agonopterix "pallidior"*, DEEUR 6645; distal half of forewing reduplicated.

generic species. Therefore, an extensive comparison with other species is useless. Instead, our description focuses on the relevant details highlighted in figures 6–7:

- VIII segment rather narrow (width-length ratio 1:1.45 - 1:1.5 in standard preparation); this is narrower in comparison with most other *Agonopterix* species (see Fig. 7a): *A. scopariella* (Heinemann, 1870) and *A. adspersella* (Kollar, 1832) - 1:1.8, *A. atomella* ([Denis & Schiffermüller], 1775) - 1:2.0, *A. pallorella* (Zeller, 1839) - 1:2.3, *A. carduella* (Hübner, [1817]) - 1:2.8); craniad edge of sternite VIII straight, without distinct features.
- Ostium located in the middle of the sternite VIII, flanked by triangular structures placed at the connection between ostium and ductus bursae; these structures are rather narrow, only slightly diverging (7b).

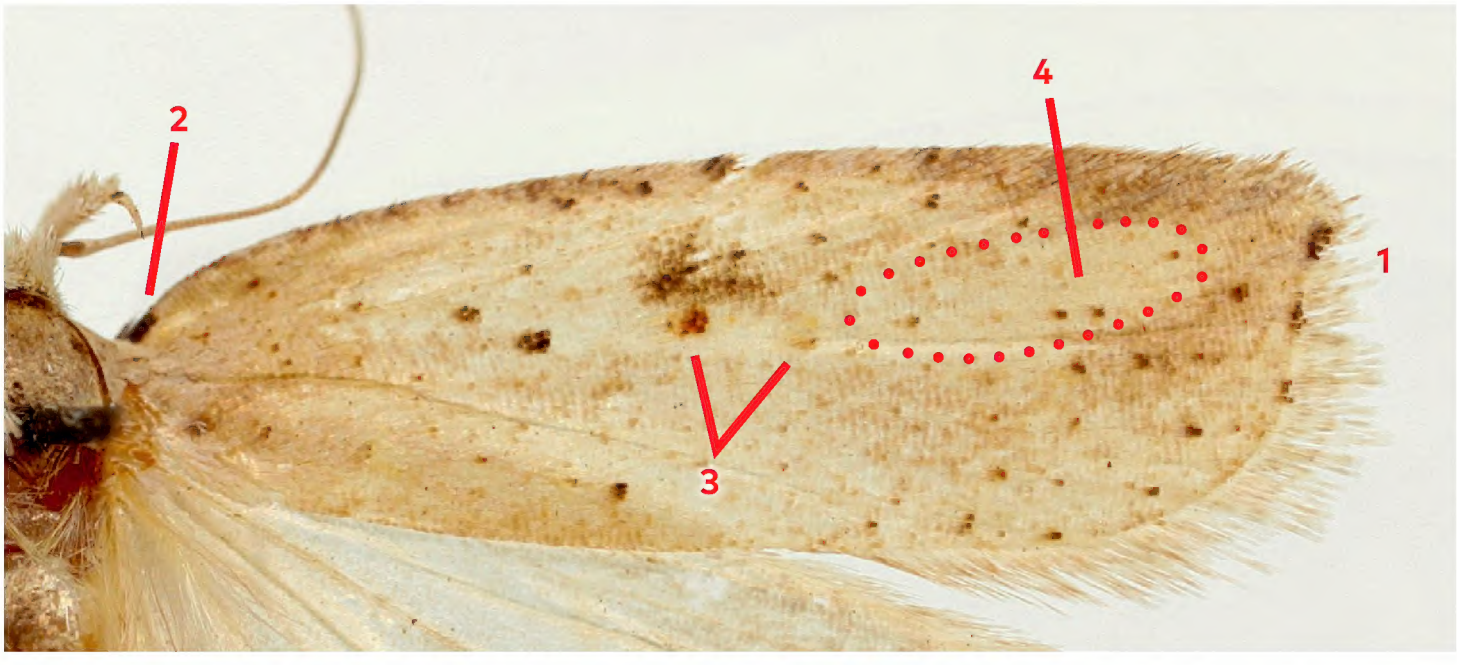
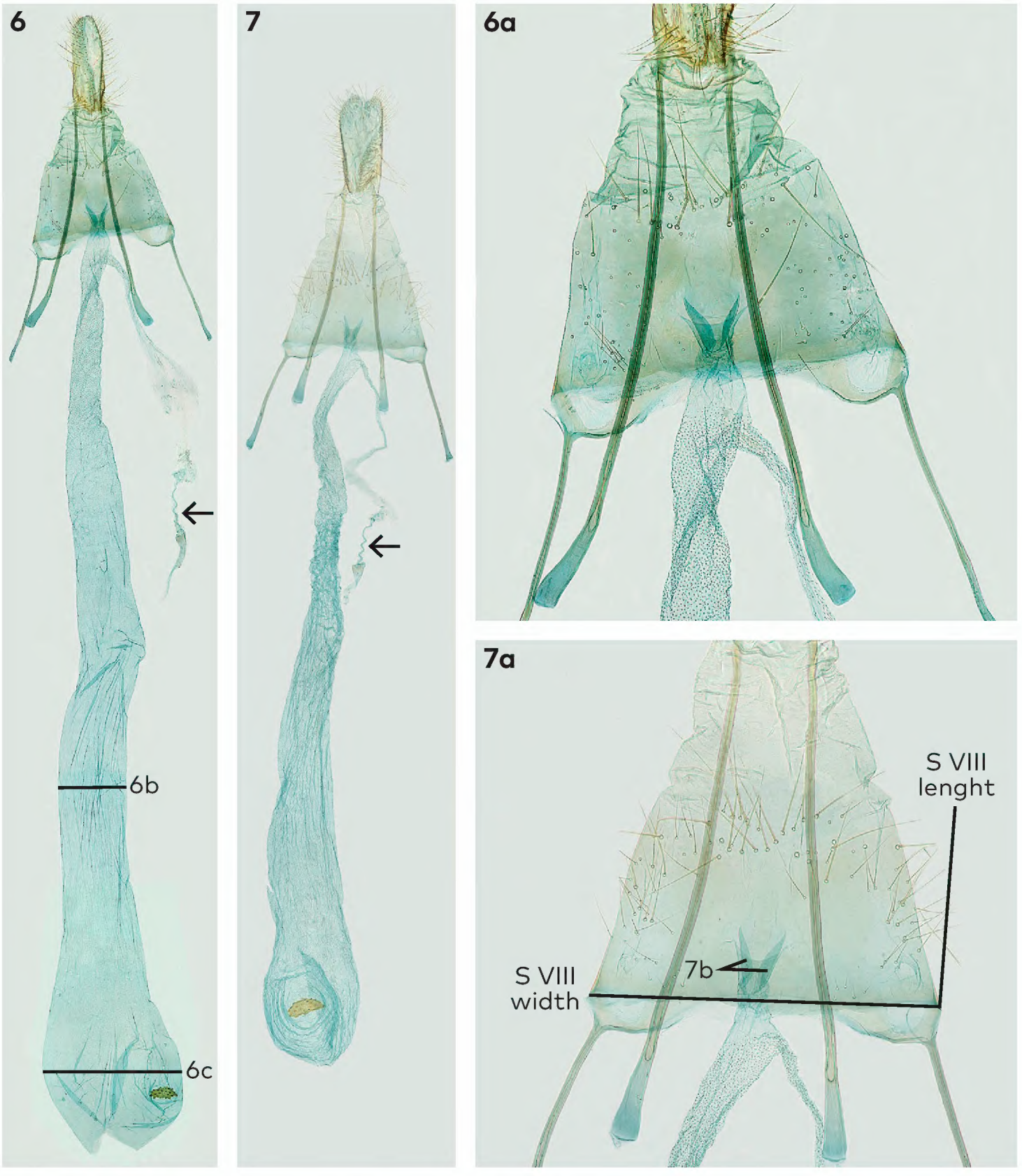


Figure 5. *Agonopterix lacteella*, holotype, right forewing enlarged; features that match *A. pallidior* are indicated with the same numbers as in figs 3 and 4.

- Ductus bursae without distinct structures, gradually widening along its course: its section reaches 1/2 – 2/3 of the corpus bursae's diameter (6b/6c), giving no clear limit between ductus and corpus bursae.
- Ductus spermatheca with about 4 turns, a rather low number within the genus *Agonopterix*.

Male genitalia (Fig. 8): Cuiller rather straight, with similar width over its entire length and indistinctly pointed. Gnathos elliptic (length/width ratio about 2.5),



Figures 6-7. *Agonopterix lacteella*, female genitalia. 6: holotype, 7: specimen DEEUR 5921. 6a, 7a – detailed view of the VIIIth sternite. For further inserts see text.

Figure 8. *Agonopterix lacteella*, male genitalia. Specimen DEEUR 6515.

pointed, exceeding socii by half of its length in standard preparation. Socius is almost triangular in shape, with a rather straight caudal edge and thus clearly different from the usual form, which is circular or elliptic and evenly rounded. Anellus broad, of elliptic shape, without a distinct incision and appendages on its upper margin, leaving a broad gap to transtilla. Anellus lobes large, the very broad elliptic appendages nearly touching in standard preparation (which means appendages are oriented towards the centre) and overlapping anellus. Transtilla of medium width, slightly broadened in the middle; transtilla lobes of medium size, leaving a clear gap between each other and anellus lobes. Indistinctive outline of valva, like many of the other *Agonopterix* species. Phallus rather stout (length/width-ratio in lateral view about 5–5.5), basal process rather short (free section about 15% of phallus length) and blunt rounded in ventral view.

There is also no single distinctive feature of male genitalia in this species. The combination of features has to be checked, the shape of socii and anellus lobes being the most important.

Distribution: A Far Eastern species, found in Russia (Lower Amur region, Primorskii region; Lvovsky 2016), Korea, north-west China (e.g. Heilongjiang District) and Japan (Hokkaido, Honshu, Shikoku, Kyushu).

Biology: Data on preimaginal stages are scarce and somewhat contradictory. According to HOSTS database (Robinson et al. 2010), larvae of *A. pallidior* have

been found in Korea on *Acer sp.* (Aceraceae) and *Phellodendron amurense* (Rutaceae). However, this finding couldn't be confirmed by any other source. Larvae of *A. pallidior* have been reared on *Maackia amurensis* (Fabaceae), this being the only mentioned food-plant on the online guide of the Japanese moths (http://www.jp-moth.org/Depressariidae/Agonopterix_pallidior.html). Some of the investigated specimens have been reared on *Maackia amurensis*, thus supporting this finding.

According to the data found on the labels of the investigated specimens, reared specimens have emerged in mid-summer (July 6–July 20), a specimen in good condition having been caught on October 3 and another specimen in shabby condition caught on May 14, suggesting that this species overwinters in the adult stage.

Molecular Data: All Depressariidae specimens with a full length barcode identified at the species level in the DEEUR-project have been used, i.e. a total of 1247 specimens from 211 species.

Barcode gap analysis indicates *Agonopterix atomella* as the nearest neighbour, with 3.26 % p-distance. Neighbour-joining tree was constructed under Kimura 2 parameter. The section with *A. lacteella* (two specimens still mentioned as *A. pallidior* in BOLD-database) is found in fig. 11. A significant feature is that nearly all Fabaceae-feeding species from within the genus *Agonopterix* are lined up here: *A. atomella* ([Denis & Schiffermüller], 1775), *A. comitella* (Lederer, 1855), *A. conciliatella* (Rebel, 1892), *A. lacteella* (also as *pallidior*), *A. nervosa* (Haworth, [1811]), *A.*

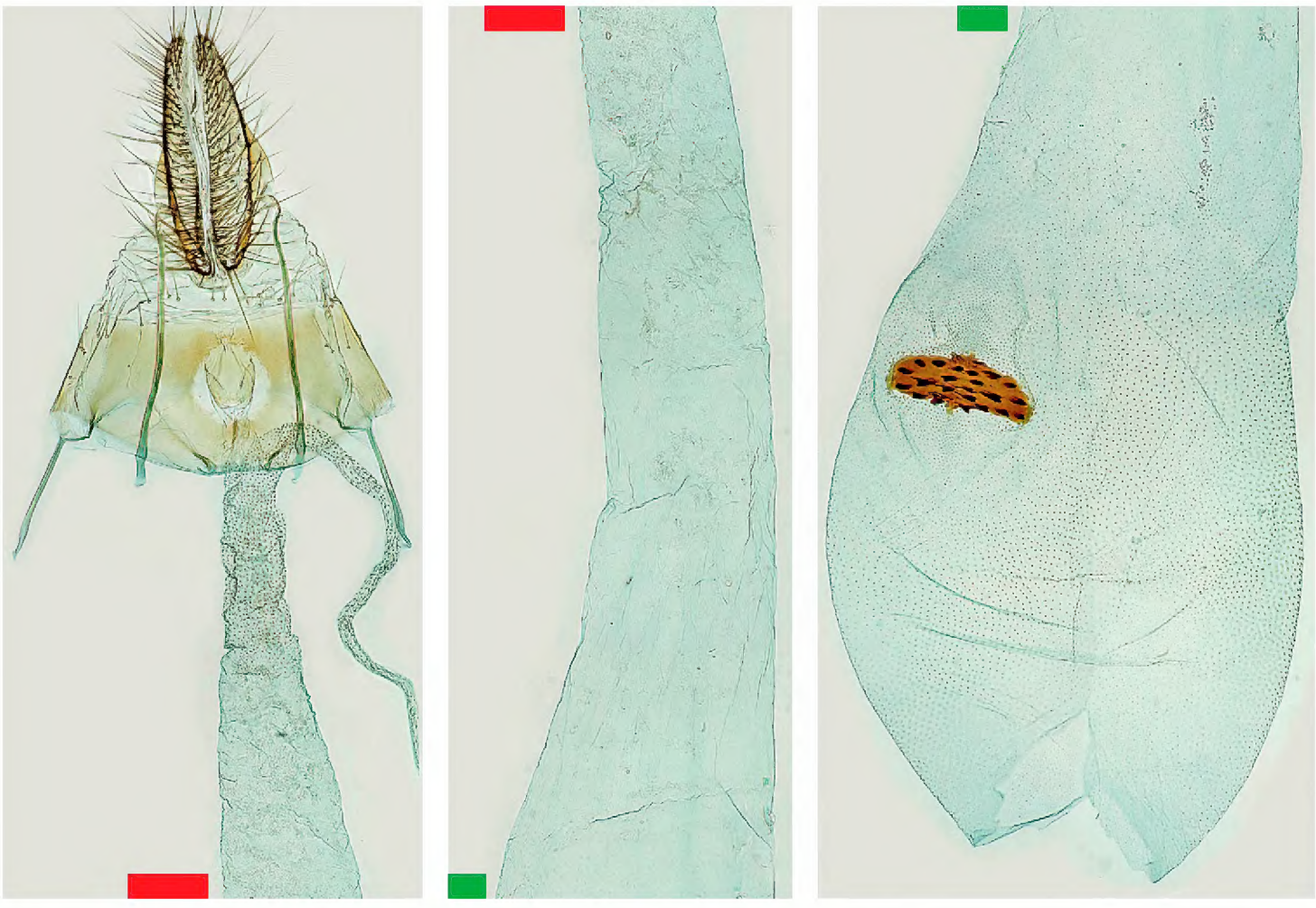


Figure 9. *Agonopterix atomella*, female genitalia. Lower Austria, 3.IV.2012, specimen DEEUR 1491. Red and green bars denote where sections have to be joined.

oinochroa (Turati, 1879), *A. rimantasi* Lvovsky, 1985, *A. scopariella* (Heinemann, 1870) and *A. umbellana* (Fabricius, 1794). This finding supports the idea that the above mentioned species form a natural group.

All sequences of the Fabaceae-feeder shown in fig. 11 can be accessed via the public dataset DS-DEEUR350, starting from public data portal http://www.boldsystems.org/index.php/Public_BINSearch?searchtype=records.

Related species: Comparison of the genitalia from both sexes between *A. lacteella* (Figs 6–8) and *A. atomella* (Figs 9–10) reveals a remarkable similarity: in male genitalia, especially the shape of anellus lobes and the cuiller are almost identical, a plain difference being found only in the shape of socii. Female genitalia correspond in the location and details of ostium, as well as the structure of ductus bursae by showing no distinct structures and a gradual widening along its course with corpus bursae only staggered vaguely. Differences are found in the shape of the VIIIth seg-

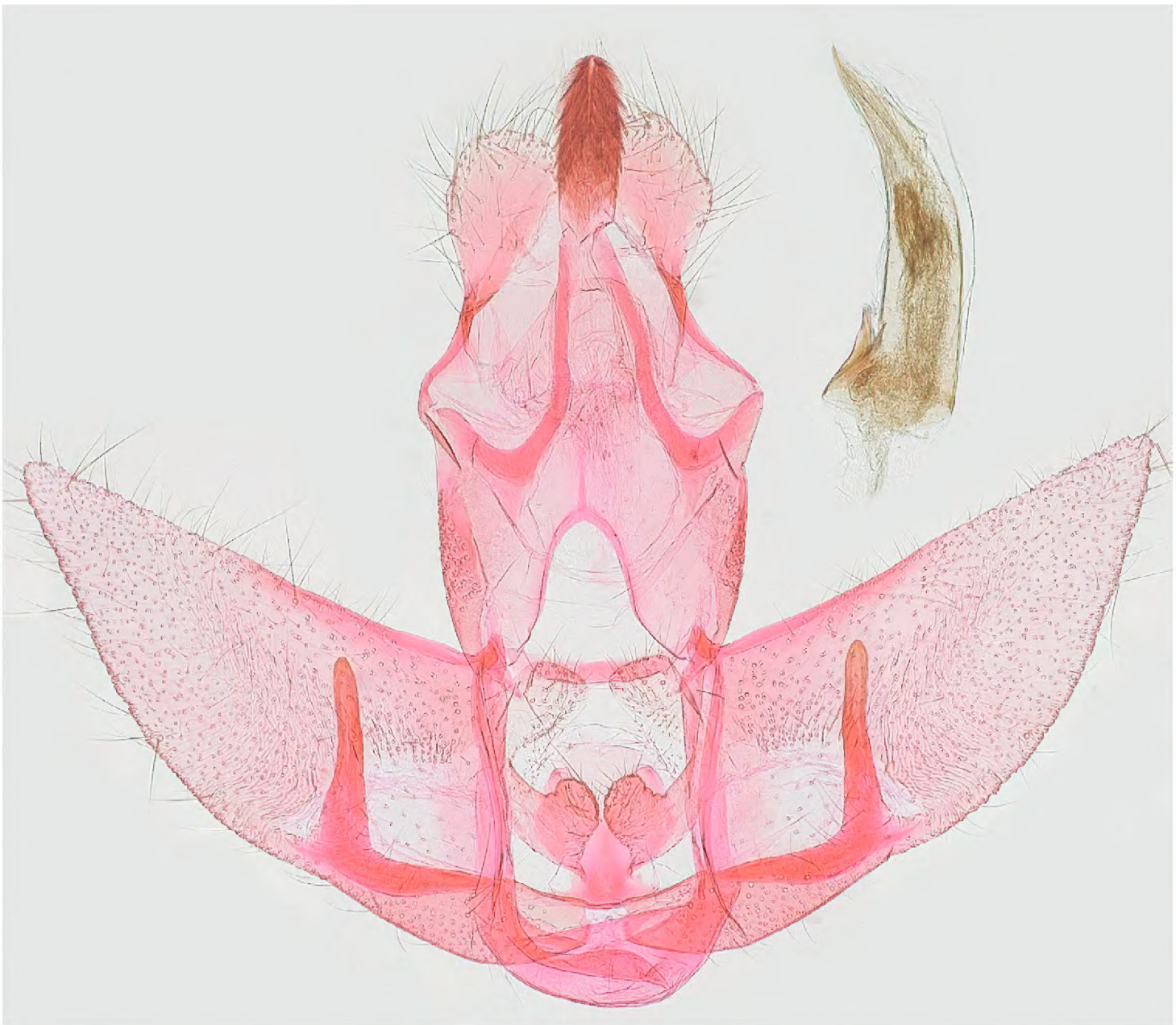


Figure 10. *Agonopterix atomella*, male genitalia. Italy, Friuli, 4.IV.2001, leg. L. Morin, specimen DEEUR 1570.

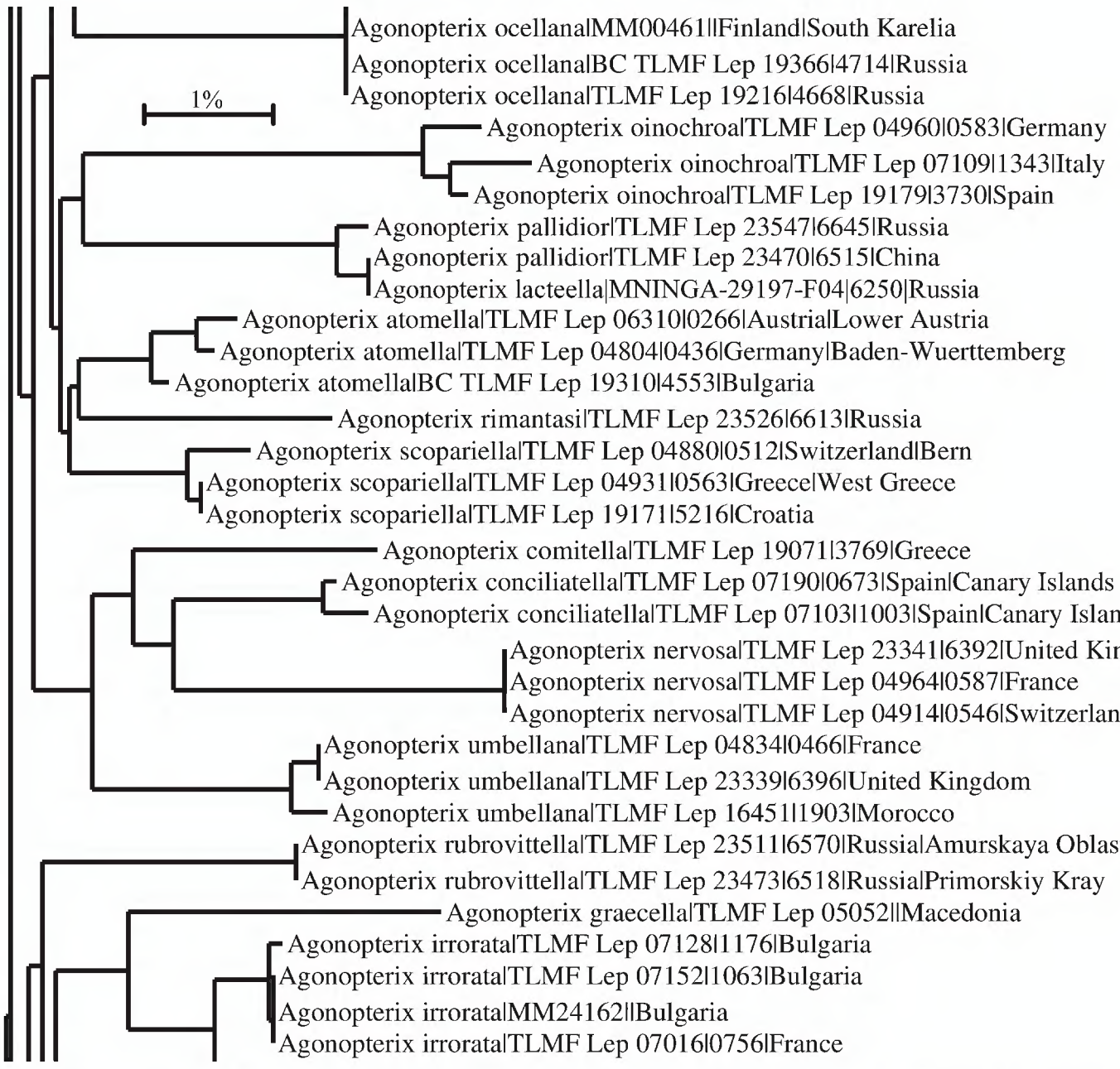

Agonopterix ocellana|MM00461||Finland|South Karelia
Agonopterix ocellana|BC TLMF Lep 19366|4714|Russia
Agonopterix ocellana|TLMF Lep 19216|4668|Russia
1%
Agonopterix oinochroa|TLMF Lep 04960|0583|Germany
Agonopterix oinochroa|TLMF Lep 07109|1343|Italy
Agonopterix oinochroa|TLMF Lep 19179|3730|Spain
Agonopterix pallidior|TLMF Lep 23547|6645|Russia
Agonopterix pallidior|TLMF Lep 23470|6515|China
Agonopterix lacteella|MNINGA-29197-F04|6250|Russia
Agonopterix atomella|TLMF Lep 06310|0266|Austrial|Lower Austria
Agonopterix atomella|TLMF Lep 04804|0436|Germany|Baden-Wuerttemberg
Agonopterix atomella|BC TLMF Lep 19310|4553|Bulgaria
Agonopterix rimantasi|TLMF Lep 23526|6613|Russia
Agonopterix scopariella|TLMF Lep 04880|0512|Switzerland|Bern
Agonopterix scopariella|TLMF Lep 04931|0563|Greece|West Greece
Agonopterix scopariella|TLMF Lep 19171|5216|Croatia
Agonopterix comitella|TLMF Lep 19071|3769|Greece
Agonopterix conciliatella|TLMF Lep 07190|0673|Spain|Canary Islands
Agonopterix conciliatella|TLMF Lep 07103|1003|Spain|Canary Islands
Agonopterix nervosa|TLMF Lep 23341|6392|United Kingdom
Agonopterix nervosa|TLMF Lep 04964|0587|France
Agonopterix nervosa|TLMF Lep 04914|0546|Switzerland
Agonopterix umbellana|TLMF Lep 04834|0466|France
Agonopterix umbellana|TLMF Lep 23339|6396|United Kingdom
Agonopterix umbellana|TLMF Lep 16451|1903|Morocco
Agonopterix rubrovittella|TLMF Lep 23511|6570|Russia|Amurskaya Oblast
Agonopterix rubrovittella|TLMF Lep 23473|6518|Russia|Primorskiy Kray
Agonopterix graecella|TLMF Lep 05052||Macedonia
Agonopterix irrorata|TLMF Lep 07128|1176|Bulgaria
Agonopterix irrorata|TLMF Lep 07152|1063|Bulgaria
Agonopterix irrorata|MM24162||Bulgaria
Agonopterix irrorata|TLMF Lep 07016|0756|France

Figure 11. Neighbour-joining tree of *Agonopterix lacteella* and related species. The nodes of *A. ocellana* and *A. rubrovittella* (Caradja, 1926), *A. graecella* Hannemann, 1976 and *A. irrorata* (Staudinger, 1871) are located outside this section.

ment by being not as narrow and in the craniad edge of VIIIth sternite by having a pair of folds.

Using the same family of food-plant, being the nearest neighbour in barcode gap analysis and presenting very similar genitalia, *A. atomella* is, without doubt, a closely related species. The question if this is the closest relative of *A. lacteella* must remain open, since data on the *Agonopterix sp.* species from Far East are still not detailed enough to allow a definite conclusion.

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